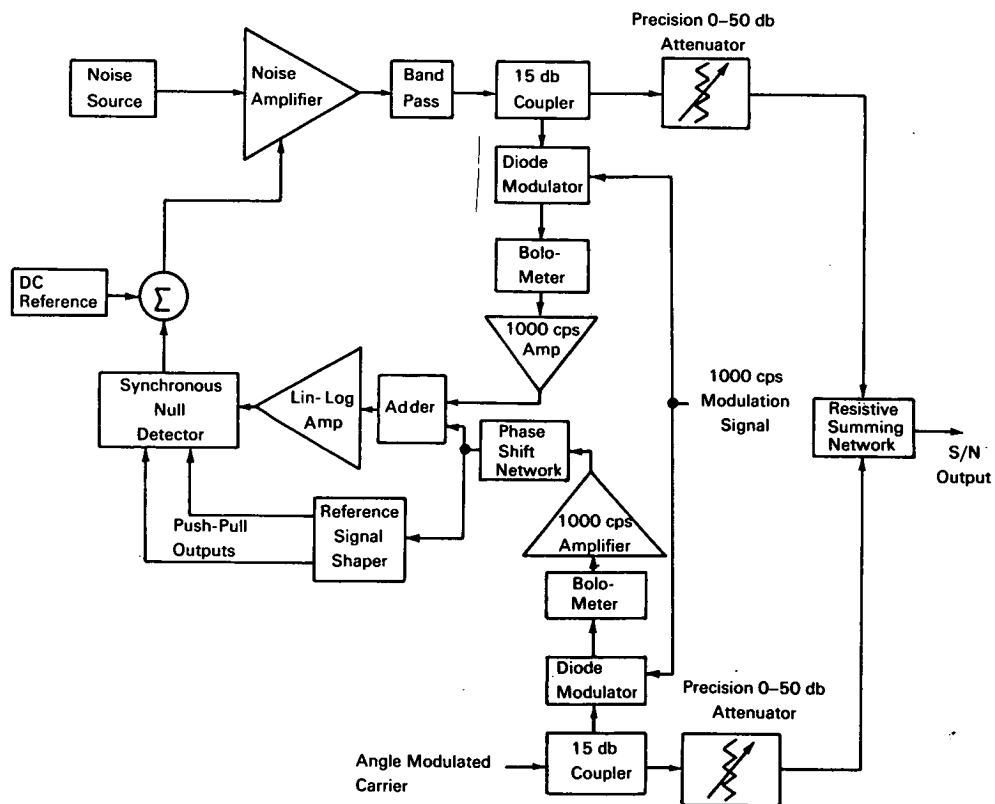


NASA TECH BRIEF



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Linear Signal Noise Summer Accurately Determines and Controls S/N Ratio



The problem:

To design a linear signal noise summer that will accurately determine and control the power level ratio of two independent signals, namely signal and noise. It is often necessary in generating and measuring RF signals to know accurately the power level ratio between two independent signals. When certain types of per-

formance tests are run on a receiver system it is necessary to mix corrupting noise with the desired signal inputs in known ratios and measure detection as a function of varying S/N ratio. The problem arises in precisely controlling the relative power levels of the signal and noise, and mixing them linearly in accurately known ratios.

(continued overleaf)

The solution:

Reference the noise power to the signal power and feed back through a servo loop any differences in power which result from changes in either of the power levels, and gain-control the noise power level. The noise power is referenced to the signal power such that changes in the signal level are not reflected as changes in S/N ratio but rather as a change in absolute signal and noise power levels.

How it's done:

Noise is generated through a temperature limited diode and is amplified to a broadband linear amplifier and band limited to a 5-pole Butterworth filter. The noise source is matched to the 50-ohm amplifier front end. The effective noise bandwidth of the system is established by the Butterworth filter.

The band-limited noise is sampled from the noise channel through a 15 db coupler and chopped at 1000 cps in a diode modulator. The modulated noise is then envelope-detected in a broadband bolometer and applied to a low noise narrow band 1000 cps tuned amplifier. The angle modulated carrier is similarly sampled, modulated, detected, and amplified to be vectorially compared with the 1000 cps detected noise envelope for synchronous null detection. The synchronous null detector provides an output about a preset dc level. The dc reference is a zener voltage adjustable in level and preset to a desired automatic gain control (AGC) operating point on the noise amplifier.

The 1000 cps carrier detected signal used as a reference signal is applied to a constant amplitude phase shifting network which has 360° of phase shifting capability without a change in amplitude. Vectorial comparison of the reference signal and noise signal is made in an adder circuit. From the adder output, the resultant signal is fed to a lin-log amplifier providing maximum sensitivity at small amplitude differences. The output of the lin-log amplifier is applied to the control grid of the synchronous detector. A second signal taken from the phase shift network output is applied through a limiter and square wave shaping circuit to a push-pull amplifier which in turn is used to drive the deflection plates of the synchronous detector. The synchronous detector difference output is then summed with the dc reference. The noise power is therefore referenced to the carrier such that changes in either of the two levels are not reflected as changes in the S/N ratio.

With the noise power level accurately defined in bandwidth through the noise filter and referenced directly to the angle modulated carrier through the feedback loop, accurate noise levels and signal levels are set through precision 50-ohm attenuators. There are two attenuators, one in each channel (i.e., the noise channel and the carrier channel) with 0-50 db range each for a total of 100 db S/N ratio range. The power levels set through the precision attenuators are then summed through a linear resistive 50-ohm network for accurate S/N ratios.

Extensive performance tests were conducted on this S/N summer with the following results:

S/N Ratio Accuracy	$\pm .156$ db over 100 db range
S/N Ratio Repeatability	$\pm .024$ db
S/N Ratio Stability	$\pm .013$ db over 4 hour period
Noise power spectral density	$\pm .05$ db over 4 Mc centered at 50 Mc

The advantages of this technique over present techniques are:

1. Improvement of S/N ratio accuracies by an order of magnitude.
2. S/N ratio accuracy does not depend on the measurement accuracy of the independent power levels.
3. Accuracy and stability of S/N ratios are attained simultaneously.
4. The technique can be used for various types of carrier modulation and for different types of independent signals not necessarily noise and carrier signals.
5. The technique is less expensive and simpler than techniques which employ independent servo loops to control the power levels.

The disadvantage of this technique is that the S/N ratios are relative and changes in carrier power are reflected as changes in the absolute signal and noise power levels.

Note:

Inquiries concerning this innovation may be directed to:

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Reference: B66-10433

Patent status:

No patent action is contemplated by NASA.

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